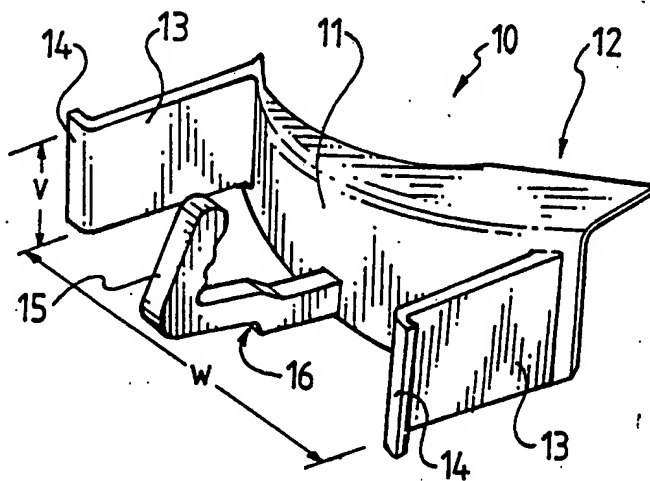




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: ROTARY LAWNMOWER ATTACHMENT



## (57) Abstract

In its preferred form, the present invention provides a removable plug (10) for use with a rotary lawnmower which is designed to be inserted via a discharge chute opening of the lawnmower, so that when the plug has been correctly inserted, the discharge opening is substantially occluded, forming a completely enclosed blade housing. The plug (10) may also be fitted to a conventional rotary lawnmower in conjunction with a chute insert (20) which is fitted within the discharge chute, which interfaces with the removable plug (10) to form a completely enclosed blade housing. This is to encourage mulching and dispersal of clippings below the blade-set into the lawn, by redirecting airflow created by the blade-set during operation.

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## **Rotary Lawnmower Attachment**

### **5 Field of the Invention**

The invention relates to conventional rotary lawnmowers, specifically those with a discharge opening for catching or spreading of the cut grass clippings, leaves and the like and more particularly to lawnmowers with rear mounted discharge openings.

10

### **Problem to be Solved**

Rotary lawnmowers which are designed for catching or spreading of the cut grass clippings are not well suited for mulching and dispersing the said clippings below the blades, down into the lawn.

15

Such lawnmowers for the most part feature a blade housing with a discharge chute which is designed in such a fashion as to direct the airflow, and hence the clippings, leaves and the like out of the housing, whether to be spread on the lawn or collected in a container. In order to mulch the said clippings finely and disperse the same downwards into the lawn effectively, a re-direction of the air-flow is required.

20

Therefore the blade housing should preferably be fully enclosed, which necessitates closing off the discharge opening. Shutting the hinged flap at the discharge opening (provided on many lawnmowers) is not a satisfactory solution on its own, as such devices do not sit closely enough to the sweep of the blade-set to prevent grass clippings and the like from being dropped into the resultant gap, and hence left behind on the lawn, rather than being dispersed satisfactorily into the cut lawn. Preferably, the discharge opening closure should enclose the blade sweep in a continuous arc with the blade housing and at a similar distance from the blade sweep as the housing itself (usually about 5 millimetres or so).

25

30

Fitting a plate permanently across the discharge opening is not desirable, as the utility of the lawnmower is then restricted solely to mulching. Providing the user with a useful choice of operations is desirable, namely either discharging the clippings or mulching the clippings into the lawn, and should be safe and convenient.

35

### Prior Art

- Attempts in the prior art to provide a lawnmower with a rear discharge opening which may be configured for either discharging or mulching the clippings for the most part provide a plate which is to be fixed inside the blade housing with bolts, clips or similar means. Such a plate is usually positioned from within the blade housing, requiring the user to place his or her hands inside the housing to do so. This system is not satisfactory, as it is considered to be inconvenient and unsafe.
- Furthermore, the discharge chutes on such mowers are generally partitioned internally so as to be of substantially less width than that allowed across the rear of the lawnmower (between the rear wheels), resulting in a tendency to clog when catching, particularly in wet conditions due to the resulting restriction. In comparison it should be noted that modern rear discharge lawnmowers designed with provision for collection of the clippings into a grass catcher generally feature a non partitioned discharge chute, resulting in a discharge opening extending substantially across the full width of the rear of the lawnmower between the wheels. Such a chute design is preferable due to the lessened tendency towards clogging when collecting the clippings.
- An attempt has been made to furnish a blade housing which readily allows a discharge opening to be closed off suitably for mulching purposes, by lowering a hinged flap over an opening positioned in the side of the chute, as described in US Patent 3132457. However, the resultant side mounted catcher is not desirable in many instances due to the overall increase in the width of the lawnmower when the catcher is fitted.
- Furthermore, such a discharge system is prone to clogging, particularly in wet grass. The prior art includes a number of other attempts to provide a suitable system, such as US Patent 2734327 describes. Complete enclosure of the blade housing is not achieved, which is unsuitable for effective mulching in many conditions. Similarly, devices such as those described in US Patents 2963841, 3226920, 3378995, 3577871 and 3905181 do not satisfactorily fulfil the purposes of the present invention.

### Object

- It is an object of the present invention to go at least part way towards providing improved apparatus and method in order to overcome the above disadvantages, or at

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least provide the public with a useful choice.

### Statement Of Invention

- 5 The present invention provides means for alternating the operation of a rotary lawnmower between mulching or catching the clippings by the insertion or removal of a plate assembly through the discharge chute opening respectively, or by opening or closing the rear flap to the discharge chute opening.
- 10 In one aspect the invention provides apparatus adapted to fit a rotary lawnmower, said lawnmower having the features of a blade housing shaped to provide a substantially circular interior wall to house a grass-cutting blade, a roof which supports an engine, a discharge chute and a discharge chute opening for the expulsion of clippings, characterised in that said apparatus includes a removable body arranged to fit within  
15 and substantially occlude the discharge chute of said lawnmower.

### Brief Description of the Drawings

- The following is a description of preferred forms of the present invention, given by  
20 way of example only, with reference to the accompanying drawings, in which:

- Figure. 1** shows a bottom view of a conventional modern rear discharge rotary lawnmower with a preferred plug body fitted
- 25 **Figure. 2** shows a top rear view of the present invention
- Figure. 3** shows a bottom plan view a preferred rotary lawnmower with the plug fitted
- 30 **Figure. 4** shows a top rear view of a preferred rotary lawnmower blade housing
- Figure. 5** shows a perspective view from one side and the body of the mower schematically cross-section of a preferred chute insert
- 35 **Figure. 6** shows a bottom view of a conventional rotary lawnmower blade housing

with a preferred chute insert fitted

Figure. 7 illustrates a rear view schematic seen through the discharge chute opening, with a preferred chute insert fitted

Figure. 8 shows a second embodiment of the present invention in top rear view.

#### Best Mode for carrying out the Invention

The numbering of parts shown in the drawings in respect of each embodiment is consistent for all different embodiments.

The first preferred embodiment as depicted in Figures 1 through 3 comprises a removable plug which when fitted within a suitable blade housing closes off the discharge chute.

The plug is preferably no smaller than necessary to be inserted through the discharge opening (with the lawnmower upright), and is designed to wedge securely within the discharge chute. The inside wall of the plug blends smoothly with the walls of the blade housing to form a continuous internal wall across the discharge chute, to re-direct the airflow inside and around the blade housing and thereby encourage mulching of the lawn clippings.

The plug cooperates with a suitable blade housing such as that shown in Fig 4, which is designed to allow complete occlusion when the plug is fitted.

A conventional rear discharge blade housing (as shown in Fig 1) may require the addition of an insert as depicted in Figs 5 through 7 within the discharge chute, in order to reduce the width of the discharge chute sufficiently for the removable plug when fitted to close off the discharge chute.

The removable plug fits securely without requiring nuts and bolts or other separate means of attachment. When correctly positioned, the plug can be held in place by means of the discharge chute flap typical of modern rotary lawnmowers, or alternatively can "snap-fit" into place within the discharge chute.

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It is a feature of the preferred design that when being inserted or withdrawn, the plug preferably cannot be made to come into contact with the lawnmower blade, thereby allowing the plug to be readily interchanged with a standard rear fitting grass catcher during operation.

5

A further feature of the preferred design is that when being inserted the plug is self clearing of clippings inside the blade housing to some degree.

10

The exact size and shape of the assemblies described above should be adapted to fit the specific lawnmower chute intended for application.

### Detailed Description of the Drawings

15

The present invention relates in particular to modern rear discharge rotary lawnmowers incorporating a discharge chute opening extending substantially across the rear of the mower between the rear wheels without a partition, as depicted in Fig. 1. This blade housing provides efficient grass catching capability with little tendency to clog in the wet.

20

A typical blade housing 1 incorporating a roof 2 for mounting a small internal combustion engine 3 or similar, with a depending shaft extending downwardly into the space within the blade housing, to which Wheels, handles, a rear discharge chute and a rear flap 5 are also provided in the prior art.

25

In order to close off the discharge chute for mulching operations, a removable plug 10 is provided which may be inserted through the discharge opening. A fixed chute insert 20 (Fig 6) which may be secured within the discharge chute may be necessary to close off any remaining gap after insertion of the removable plug 10.

30

The removable plug 10 provides a substantially vertical curved face 11 as shown in Fig 2, which blends with the wall of the blade housing 1 to complete the circular periphery of the housing wall, at a similar distance from the blade sweep, so that when the removable plug 10 is positioned in the discharge chute of the blade housing (as shown in Fig 3), the discharge chute is completely closed off.

35

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The size of face 11 is determined by the size of the discharge opening, as it must be inserted through the discharge opening. Face 11 is as wide and as high as practical for such insertion.

- 5 A forwardly projecting edge 12 can be provided across the top of face 11 to occlude any remaining slot between the top of the face 11 and the housing 1, in a swept manner. The vertical size of the face 11 may be reduced somewhat by the addition of edge plate 12. If there is no gap between the housing 1 and the top of plate 11, (depending on the height of the blade housing in relation to the size of the discharge opening), edge plate 12 may be unnecessary.

Plate 12 preferably extends forward from face 11 to sit against the inner surface of the step 9 of a conventional blade housing 1 when the removable plug 10 is fully inserted in order to provide positive positioning of the plug 10 as shown in Figs 1 & 6.

15

Plate 12 may be extended fully from side to side across the top of face 11, and gives some rigidity to the face 11, as well as providing a means for scraping off grass build-up inside the blade housing during insertion of the removable plug 10, by providing a surface which is at an oblique angle to the blade housing.

20

Preferably, guide means 13 are provided backwardly projecting from face 11 as shown in Fig 2, which support and guide insertion of the removable plug 10, as well as preventing the removable plug 10 from being twisted or displaced far enough to contact the bladeset 4 during insertion or removal. In the present example, the guide means 13 are oriented vertically and are placed as widely apart as possible for insertion through the discharge opening, so that the overall width  $w$  defined by the guides 13 as depicted in Fig. 2 is only slightly less than the breadth  $b$  of the discharge opening (as depicted in Fig 4).

25

In a similar manner, the vertical extent  $v$  of guides 13 as depicted in Fig 2 is only slightly less than the vertical height  $h$  of the discharge opening (as depicted in Fig 4), with just enough clearance between the guides and the discharge opening to allow the removable plug to be inserted fully into the discharge chute. The removable plug thereby fits snugly into place inside the discharge chute, somewhat as a wedge. Returns

30

- 35 14 may be provided on the rear of the guides to further locate the removable plug in



-7-

place.

It is to be noted that excessive movement of the plug 10 could allow contact by face 11 or plate 12 with the mower blades 4, and is therefore not desirable.

5

Preferably a handle 15 is provided on the removable plug 10 to manipulate the removable plug in and out of the discharge chute opening. The handle incorporates a notch or step 16 which is positioned so as to sit against the inside of the rear axle 8 when the removable plug 10 is fully inserted within the discharge chute, as shown in Figs. 1 & 3. The handle 15 is preferably made from material with a sufficient amount of spring or resilience to cause the step 16 to snap down into place over the inside top edge of the rear axle 8. Removal of the said plug 10 is achieved by bending the handle 15 upwards enough to allow the step 16 to clear the top inside edge of the axle 8. The axle 8 therefore preferably provides a flat inner edge for secure keying of the step 16 as shown. The step 16 is preferably small enough to allow easy removal, but at the same time is large enough to securely lock the removable plug 10 in place.

10

15

The rear flap 5 is held down onto the handle 15 by the action of a spring provided at the flap hinge-point, as per conventional mower design. The handle 15 is shaped so that the rear flap 5 fits firmly over the bottom edge of the handle 15, as shown in Fig 1. The rear flap 5 is held slightly open to give indication that the removable plug 10 is in place, while also providing a good degree of protection to the operator from any projectiles which come out from beneath the removable plug 10.

20

The removable plug 10 may be fabricated from moulded or die-cast aluminium or plastic, or alternatively formed by drawing suitable material such as steel by means of a tool and die operation, or some other suitable method such as spin forming inside a blank.

25

In most instances excess clippings inside the discharge chute can be scraped off as described, by pushing the removable plug 10 in and out several times, without needing to resort to manually cleaning off clippings inside the blade housing to insert the removable plug 10.

30

Alternative assemblies and fixing methods may be employed, such as providing a frame

35

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rearwardly from the curved face 11 or supporting arms 13 over which the return on the rear flap 5 is fitted to hold the assembly in place, in the same manner by which a grass catcher is typically attached to a conventional modern lawnmower.

- 5 Once the removable plug 10 is fully inserted within the discharge chute, the return on the outer edge of the rear flap 5 can be lowered over the outermost edge of the rearward frame. The rear flap 5 is used to secure the plug 10 within the discharge chute, which indicates that the plug 10 is fully inserted into discharge chute, as the rear flap 5 will not otherwise fit over the edge of the frame. This embodiment is not  
10 preferred, as less protection is provided to the user, as the rear flap is held open horizontally when the removable plug 10 is fitted.

- Various additional clips or connecting devices may be employed, however the preferred embodiment is considered sufficiently secure for the purpose. Furthermore, various  
15 appendages such as additional foot guards, tines or spreading flaps may also be added as desired, although such are not considered strictly necessary.

#### Modified Blade Housing

- 20 A modified blade housing can be fabricated to a shape as shown in Figure 4, to provide a discharge chute which can be fully closed off by the insertion of the removable plug 10.

- The modified blade housing 31 incorporates a roof 2 for mounting a small internal  
25 combustion engine or similar, the depending shaft of which extends downwardly into the space within the blade housing, and to which is attached a blade as per conventional rotary lawnmower design. Wheels, handles and a rear flap 5 are also provided as per conventional rotary mower prior art.

- 30 The blade housing 31 may be fabricated from moulded or die-cast aluminium or plastic, or alternatively formed by drawing suitable material such as steel by means of a tool and die operation, or some other suitable method such as spin forming inside a blank.

- 35 A discharge opening is provided at the rear of the housing 31 for the expulsion of

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clippings, which may be collected into a grass catcher fitted to the rear of the blade housing.

5 It is necessary that the width of the neck 35 of the discharge chute (depicted by  $n$  in Fig 3) is similar to the breadth  $b$  of the discharge opening as depicted in Fig 4, to allow the removable plug 10 to fully close off the discharge chute.

10 The discharge opening preferably extends across the full extent of the rear of the mower body, as shown in Fig. 4 (approximately 70% of the width of the swath cut by the bladeset 4), to minimise clogging.

15 From the front of the mower the blade housing 31 sweeps smoothly upwardly towards the discharge chute opening, so that the blade housing is approximately twice the height at the rear as at the front.

20 The top of the housing 31 at the discharge chute opening sweeps smoothly downwardly across and away from the chute opening, forming a swept face 33 as shown in Fig 4. A step is thus formed as depicted by 32 in Fig. 4, defining the top of the discharge chute, which extends forwards from the top of the discharge opening.

25 The provision of the swept face 33 reduces the necessary size of the removable plug 10, and has been found to improve circulation of airflow into and out of the grass catcher, hence improving the catching efficiency of the mower.

30 A lug or hook 34 may be provided inside the discharge chute as shown in Fig. 3, to locate the inner edge of plate 12 when the removable plug 10 is in place.

35 It is to be appreciated that reducing the width of the neck 35 of the discharge chute to the breadth  $b$  of the discharge opening will reduce the catching efficiency of the blade housing significantly in many conditions. However, it has been found that the provision of the swept face 33 shown in Fig 4 (and as provided by the insert element 23 in Fig 6) increases the catching efficiency of the blade housing sufficiently to adequately compensate for the restricted chute volume.

The overall result is that similar catching efficiency is achieved despite the overall

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reduction in volume of the neck of the discharge chute.

This preferred blade housing lends itself to the application of the removable plug 10 as described, thereby facilitating the production of a convenient dual purpose catching and mulching lawnmower.

Furthermore, such a housing is to some degree easier to mould or stamp for production as there are less corners and abrupt steps involved.

A further advantage to such a swept blade housing is the extra clearance provided around the engine 3, which could be used to accommodate a larger fuel tank, larger engine unit or to allow greater air-flow for engine cooling.

#### Example of typical dimensions:

On a rotary lawnmower having a cutting swath width of 470 mm, the width of the discharge chute opening  $b$  will be approximately 330 mm, the width of the neck of the chute  $n$  will be approx. 325 mm, the width overall of the face 11 will be approx. 324 mm, and the width  $w$  described by the guide means 13 will be approx. 328 mm.

Edge plate 12 will extend approx. 80 mm forwards from face 11. The height of the blade housing 31 will be approx. 100mm at the front and 200 mm at the rear.

The vertical extent of the discharge opening  $h$  will be approx. 175 mm, the vertical extent  $v$  of the guide means 13 will be approx. 174 mm.

#### Fixed Insert Element

In order to apply the removable plug 10 successfully to a conventional rotary lawnmower as shown in Fig 1 it is preferable to reduce the width of the neck of the discharge chute (depicted by  $n'$  in Fig 6) to a similar width (depicted by  $n$ ) as the breadth  $b$  of the discharge opening, in order that the removable plug 10 when fitted will fully close off the discharge chute.

This may be achieved with the provision of a chute insert element 20 which is to be

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attached to the top of the blade housing 1 within the discharge chute, as shown in Fig 5. It will be apparent that the shape and size of the chute insert 20 is such as not to otherwise restrict the discharge of the lawn clippings and the like via the discharge chute.

5

The chute insert 20 is preferably attached securely by bolts, rivets or other suitable means to the left hand side of the discharge chute (as viewed from behind) as shown in Figs 6 & 7. The insert element consists of a shoulder portion 21 which is preferably curved at a similar radius as the interior wall of the blade housing 1 so as to complement the interior wall shape and extend said inner wall as shown in Fig. 6.

10

Shoulder 21 has face 22 which extends rearwards towards the discharge chute opening, and preferably guides the insertion of the removable plug 10 into the neck of the discharge chute.

15

A smoothly swept dish 23 may also be provided as an integral part of plate 21 (as shown in Figs 5 through 7) so as to modify the existing roof of the blade housing 1 so that the modified roof sweeps smoothly downwardly across and away from the discharge chute opening, relative to the direction of rotation of the mower blade.

20

An internal step 24 defining the top of the discharge chute is formed which extends forwards from above the discharge opening, as shown in Fig. 6.

The elimination of the relatively abrupt step 9 typical in many modern rear discharge rotary mowers (shown in Figs 1 & 6) by swept dish 23 has been found to improve circulation of airflow into and out of the grass catcher, and hence improve the catching efficiency of the mower, as well as reducing the size of the removable plug 10.

25

The chute insert 20 may be constructed from steel, aluminium or plastic or other suitable material by means of moulds or dies, and is fixed securely inside the blade housing by means of rivets, bolts or other suitable means.

30

A lug or hook 25 may be provided on the forward edge of the swept dish 23 (Fig. 6), to locate the inner edge of plate 12 when the removable plug 10 is fully inserted.

35

### Industrial Applicability

The illustrated embodiment is intended as an attachment for use with a rotary lawnmower. In particular, the attachment can be used for mulching and dispersing lawn  
5 clippings.

### Variations

A second embodiment as depicted in Fig 8 consists of a blade housing 50 incorporating  
10 a curved discharge chute flap 51, which when open allows normal discharge of the said clippings, but when closed encourages re-direction of the air flow for mulching and dispersal of the clippings below the blade set.

The curved flap 51, which is hinged along its top edge 20, can be pivoted up in the  
15 same manner as the rear flap of a conventional lawnmower to allow discharge of clippings for catching or spreading operations.

When the curved flap 51 is pivoted to the closed position as depicted in Fig 9 it fully  
occludes the discharge chute as shown, and redirects the airflow to encourage mulching  
20 of lawn clippings, without leaving a large gap at the rear of the blade sweep into which unmulched clippings may fall.

### Advantages

25 It will be apparent that there are a number of advantages of the preferred embodiments. Clearly, the removable plug is convenient for use with a conventional rotary lawnmower and allows a lawnmower operator to swap from catching clippings to mulching the cut grass with ease. Insertion and removal of the plug body is made easy by its self-locating and self aligning assembly. Furthermore, this is an economic  
30 advantage to the owners of existing catching mowers in that it is not necessary to purchase a new mower, but instead existing mowers can be easily adapted to suit the requirements for mulching.

**Claims**

1. Apparatus adapted to fit a rotary lawnmower, said lawnmower having the features  
5 of a blade housing (1) shaped to provide a substantially circular interior wall to house a  
grass-cutting blade, a roof (2) which supports an engine, a discharge chute and a  
discharge chute opening for the expulsion of clippings, **characterised in that** said  
apparatus includes a removable body (10) arranged to fit within and substantially  
occlude the discharge chute of said lawnmower.  
10
2. Apparatus as claimed in claim 1, **characterised in that** said body includes an  
interior wall shaped (11) to complement the interior wall of the blade housing of the  
rotary lawnmower by which airflow inside said blade housing can be redirected past the  
discharge chute, to recirculate around said housing.  
15
3. Apparatus as claimed in claim 1, **characterised in that** said apparatus comprises an  
assembly shaped and dimensioned to fit into the discharge chute through the discharge  
chute opening.
- 20 4. Apparatus as claimed in claim 1, **characterised in that** said apparatus includes  
guide means (13) by which the assembly is keyed with the discharge chute so as to fit  
in a single orientation, and disengageable detent means (16) to hold the apparatus in its  
keyed position.
- 25 5. Apparatus as claimed in claim 1, **characterised in that** said apparatus includes a  
forwardly projecting edge (12) shaped to complement the roof (2) of the mower  
wherein said roof sweeps smoothly upwardly towards the discharge chute opening and  
sweeps smoothly downwardly across and away from the discharge chute opening,  
relative to the direction of rotation of the mower blade.  
30
6. Apparatus as claimed in claim 1, **characterised in that** said apparatus further  
includes a handle (15) by which the apparatus can be manipulated in and out of the  
discharge chute opening.
- 35 7. Apparatus as claimed in claim 6, **characterised in that** the said handle (15) is

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associated with the said detent means (16) so that by manipulating the handle the detent can be disengaged.

8. Apparatus as claimed in claim 1, **characterised in that** the apparatus further  
5 includes a fixed insert element (20) fitted within the discharge chute of the mower, said  
fixed insert element including a shoulder portion and a roof portion, wherein the roof  
portion is shaped to fit against and modify the existing roof (2) of the mower, so the  
said modified roof sweeps smoothly downwardly across and away from the discharge  
10 chute opening, relative to the direction of rotation of the mower blade, by which  
airflow inside said housing can be redirected past the discharge chute, to recirculate  
around said mower.

9. Apparatus as claimed in claim 8, **characterised in that** said shoulder portion (21)  
restricts the said neck of the discharge chute so that the width of said neck is less than  
15 the width of the discharge chute opening.

10. Apparatus as claimed in claim 1 **characterised in that** the body is a flap (51)  
attached at the discharge chute opening, having an interior face shaped to complement  
the interior wall of the blade housing.



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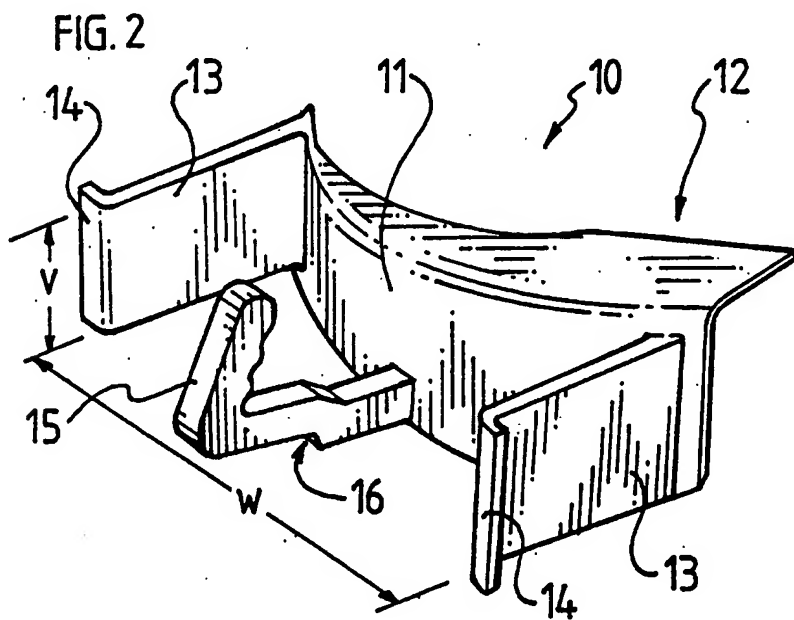
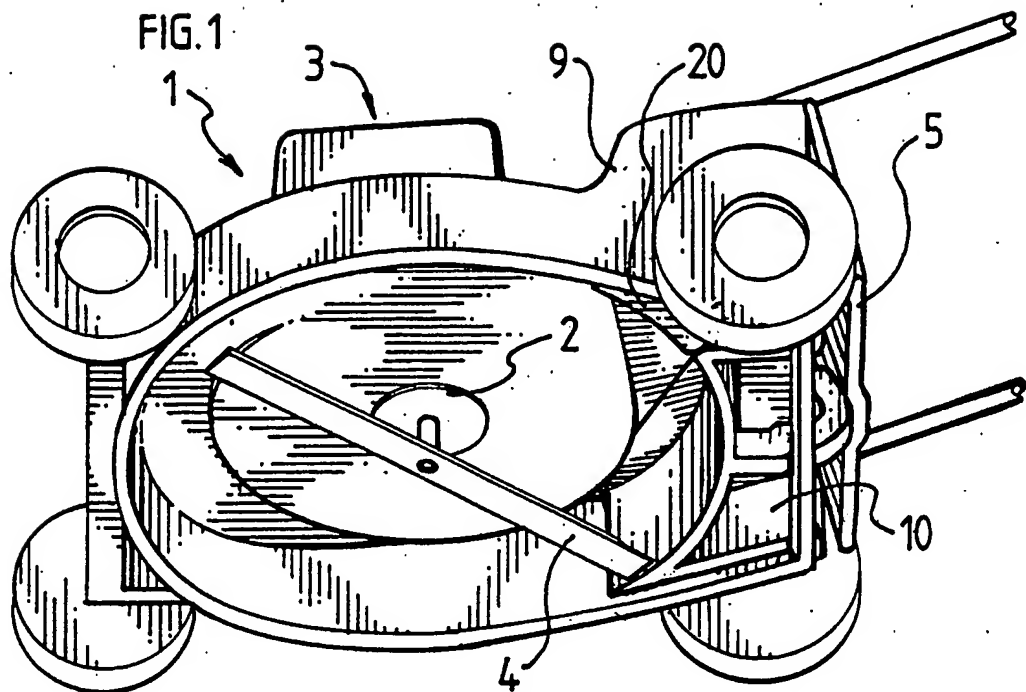


FIG. 3

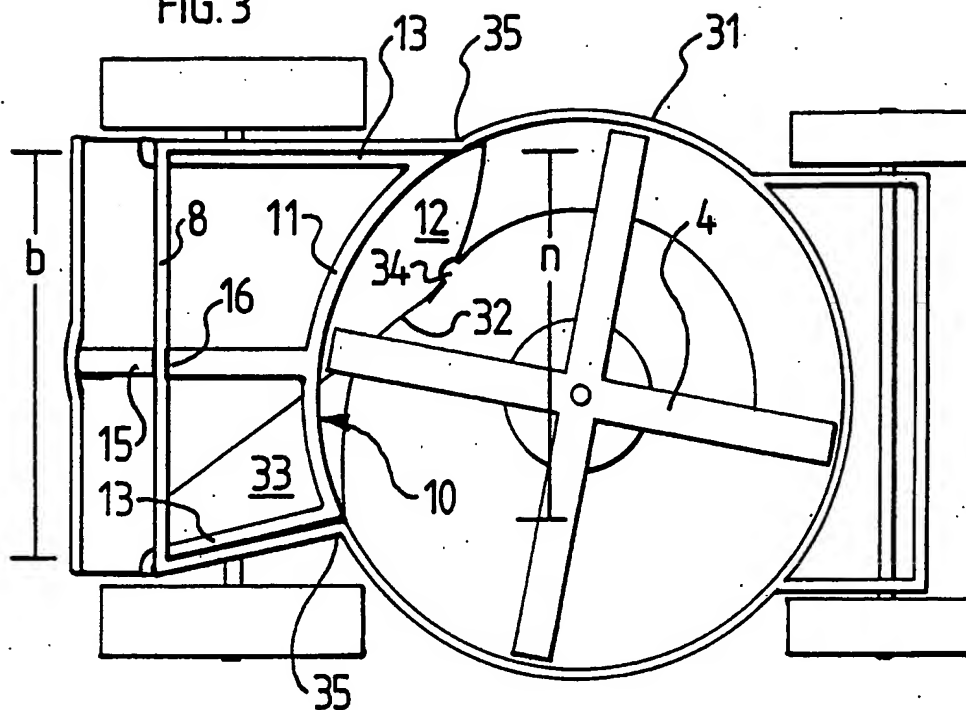


FIG. 4

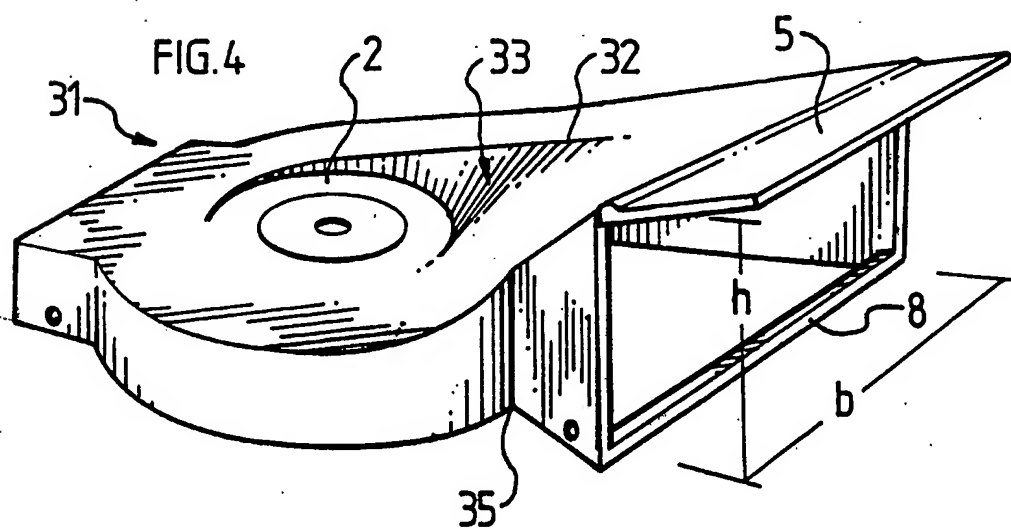


FIG. 5

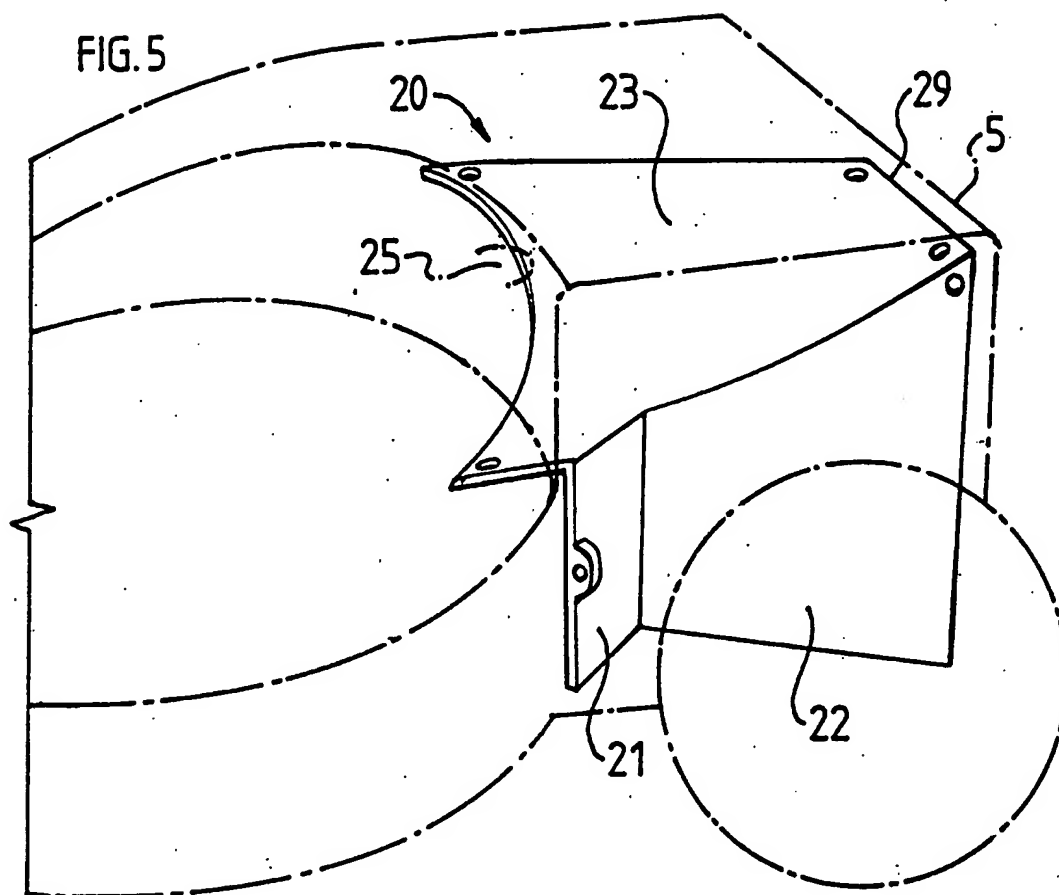
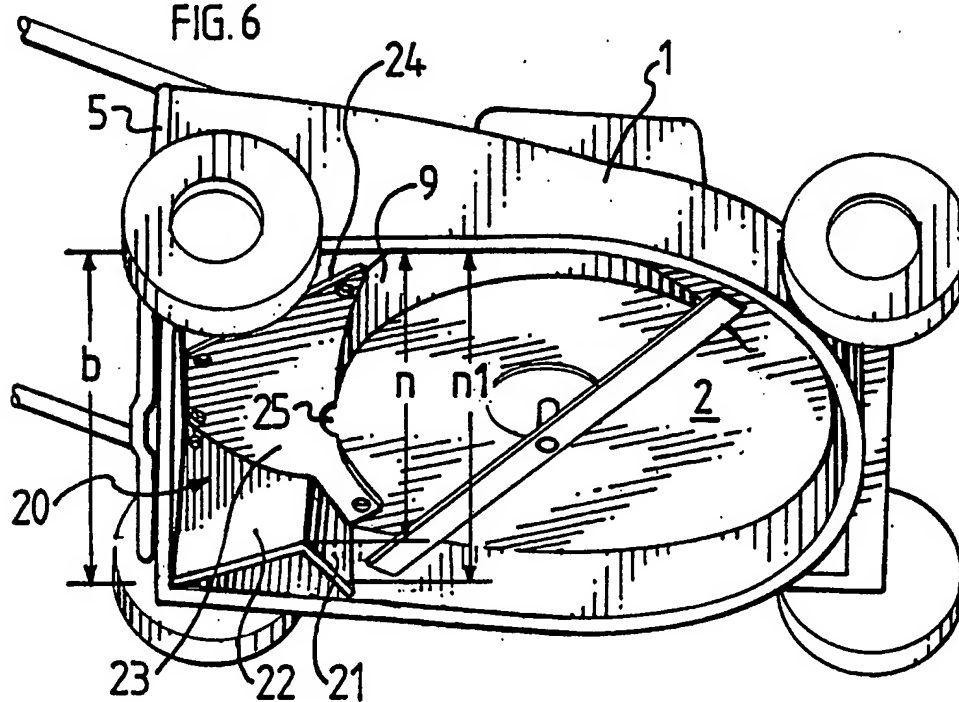


FIG. 6



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FIG. 7

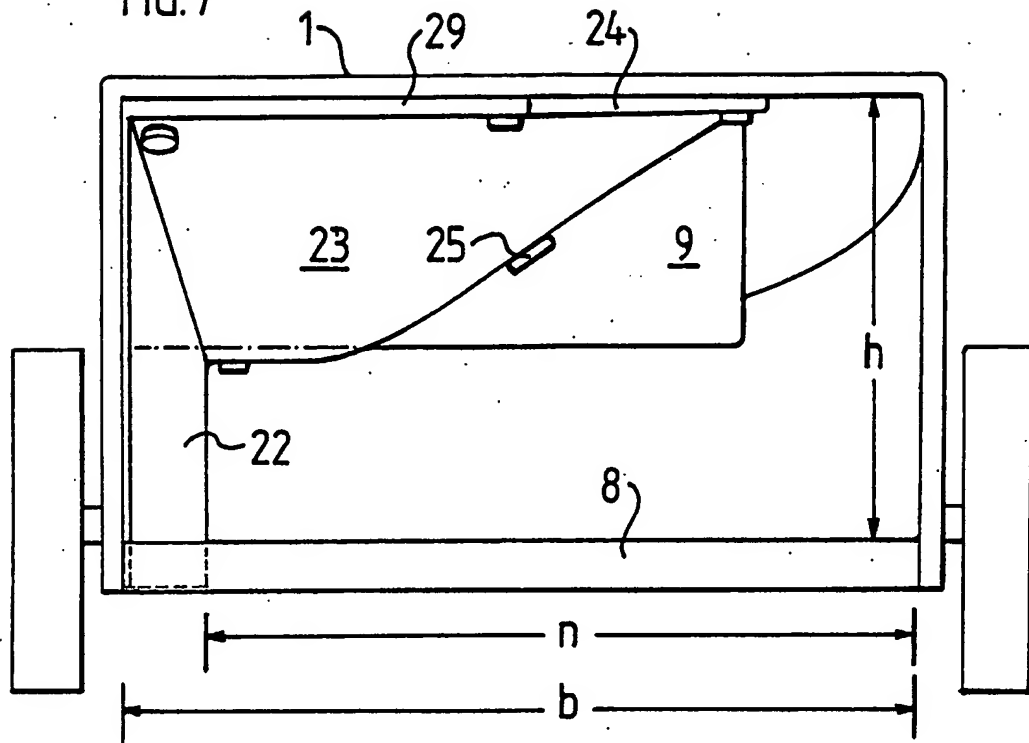
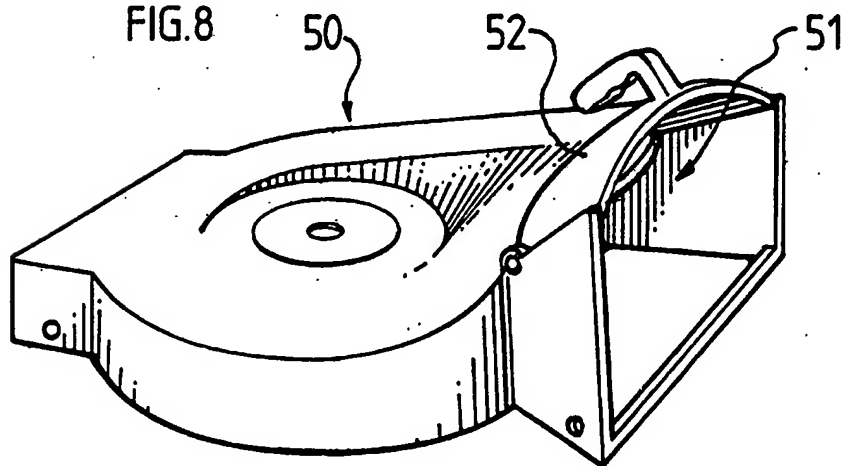



FIG. 8



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/nz 93/00115

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> Int. Cl. <sup>5</sup> A01D 34/82, 34/70  According to International Patent Classification (IPC) or to both national classification and IPC				
<b>B. FIELDS SEARCHED</b>  Minimum documentation searched (classification system followed by classification symbols) IPC: A01D 34/82, 34/68, 35/262  Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU: IPC AS ABOVE  Electronic data base consulted during the international search (name of data base, and where practicable, search terms used) DERWENT: MULCH				
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>				
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.		
X	GB,A,1584495 (SUFFOLK LAWN MOVERS LTD) 11 February 1981 (11.02.81) Whole document	1-10		
X	US,A,2687607 (EDWARD R. SEWELL) 31 August 1954 (31.08.54) See page 1, lines 1-6 and lines 40-48; Figures 1,2.	1,2		
X	AU,A,25297/84 (G. IRISH & SONS PTY LTD) 6 September 1984 (06.09.84) See page 2, line 1 and lines 15-23; Figures 1 & 3.	1		
X	US,A,4326370 (THE TORO COMPANY) 27 April 1982 (27.04.82) See page 2, lines 35 to page 3, line 18; page 7, lines 36-56; pages 13 and 14; Figures 1, 2, 6, 7.	1-10		
<div style="display: flex; justify-content: space-between; align-items: flex-start;"> <div style="width: 45%;"> <input type="checkbox"/> Further documents are listed in the continuation of Box C.         </div> <div style="width: 45%;"> <input checked="" type="checkbox"/> See patent family annex.         </div> </div>				
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </td> <td style="width: 50%; vertical-align: top;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle of theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p> </td> </tr> </table>			<p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle of theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p>
<p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle of theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p>			
Date of the actual completion of the international search 5 April 1994		Date of mailing of the international search report 20 April 1994 (20.04.94)		
Name and mailing address of the ISA/AU  AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA  Facsimile No. 06 2853929		Authorized officer    R. KIRBY  Telephone No. (06) 2832369		

**Box I** Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international search report has not established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claim Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II** Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

**INTERNATIONAL SEARCH REPORT**  
Information on patent family member.

International application No.  
**PCT/**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member
GB 1584495	
US 2687607	
AU 25297/84	
US 4326370	
END OF ANNEX	